NEWSLETTER

No. 92-1 JAN 92

JOINT TACTICAL COMMUNICATIONS

OPERATIONS DESERT SHIELD - DESERT STORM

CENTER FOR ARMY LESSONS LEARNED (CALL)
U. S. ARMY COMBINED ARMS COMMAND (CAC)
FORT LEAVENWORTH, KANSAS 66027-7000

FOREWORD

A joint communications system aids two or more armed forces in their execution of a tactical or strategic mission. The system enables the exchange of instructions and information between the armed forces. This CALL newsletter provides military units that participate in joint tactical operations with interoperability lessons collected from Operations DESERT SHIELD and DESERT STORM.

Joint command, control and communications (C3) systems are set apart from service-unique systems in various ways. These systems require agreements and standards among the services. There must be agreement to develop and produce the same equipment or to adhere to common technical interface specifications; to fund and field equipment simultaneously; and to implement common procedures, languages, or protocols. Agreement means compromise which causes the relinquishing of some individual desires for the common goal. In the present environment, interoperability enhances the overall ability to accomplish the mission and save lives. As recent military confrontations have shown, interoperability between services is required more at the tactical level than in the past where services tended to operate individually.

Many of the lessons in this newsletter were collected from CINCFOR FCJ3-TJ, Joint Interoperability Division, based on a request for support from USCENTAF. The tasking to CINCFOR was to support the Area Air Defense Commander (ADC) in theater and develop a Joint Tactical Air Operations (JTAO) interface for theater-wide operations. The theater of operations included the Saudi Arabian peninsula and adjacent waters. The objective for the CINCFOR contact team was to develop a theater-wide, single JTAO interface for the integration of US tactical data systems with Host Nation and Allied force systems. The contact team also monitored the conduct of the JTAO interface. These lessons are a result of the experience and the completion of the objectives.

CALL thanks the CINCFOR contact team for the contents of this newsletter and the agencies that provided comments during staffing.

MICHAEL S. DAVISON, JR.
Brigadier General, USA
Deputy Commanding General for Training

JOINT TACTICAL COMMUNICATIONS

TABLE OF CONTENTS

Unless otherwise stated, whenever the masculine or feminine gender is used, both are intended.

COMBINED ARMS CENTER

Deputy Commanding General for Training
Brigadier General Micheal S. Davison, Jr.

CENTER FOR ARMY LESSONS LEARNED

Director
COL Huey B. Scott

Managing Editor
MAJ Rick Bogdan

Editor/Layout and Design
Ms Mary Sue Winneke

Writers
CPT Jimmy W. Whiteley
Dr. Lon R. Seglie

Contributors
Joint Interoperability Division, U.S. Army Forces Command;

Joint Tactical Command, Control, and Communications Agency;

U.S. Army Signal Center and Fort Gordon;

Spectrum Management Office, HQDA;

Army Communications-Electronics Command;

Test and Experimentation Command

Distribution
SFC Micheal Noone
Ms Lisa Matthews

NOTE: Any publications referenced in this newsletter (other than the CALL newsletters), such as ARs, FMs, TMs, must be obtained through your pinpoint distribution system.

CHAPTER 1

COMMAND AND CONTROL (C2)

TOPIC: Combined Coordination Staff.

DISCUSSION: The U.S. and Saudi Arabian commanders formed a combined coordination staff in the form of the Coalition, Coordination, Communication, and Integration Center (C3IC). The C3IC was a joint, combined organization which had the primary focus of coordinating U.S. and Saudi land operations. Each side of the coalition effort was headed by a major general. The C3IC consisted of a number of Army, Navy, Air Force, Marine officers, and a Saudi contingent. The focus was primarily on land operations. The organization coordinated and shared information and worked issues for U.S. and Saudi forces. It was a balance between a formal and informal setting where one country did not appear to dominate the other. Due to U.S. experience in large synchronized combined operations, U.S. planners tended to take the lead in operational planning while the Saudis provided input. Usually, the Saudis accepted U.S. recommendations on land operations. Carefully selected personnel staffed the C3IC and were able to understand and communicate with personnel from a different culture. Both the U.S. and Saudi major generals communicated with their respective military to ensure that a unity of effort was maintained.

LESSON(S): A joint, combined organization must be established to coordinate military operations during coalition operations.

TOPIC: Data-Link Architecture Planning.

DISCUSSION: Mission planning sessions for data-link architecture and system employment would have been enhanced by more face-to-face involvement by actual participants. The C2 structure and data-link architecture (joint and combined) employed are of sufficient scope and complexity to warrant maximum preplanning and briefing among participants where possible. This is especially important where primary interface participants (Tactical Air Control Center (TACC), Airborne Early Warning and Control System (AWACS), U.S. Navy (USN) assets) are involved. Physical locations (close proximity) of the TACC Message Processing Center (MPC), functioning as the Interface Control Unit (ICU), the AWACS planning cell, and naval assets in port afforded an excellent opportunity for a rapid and effective mutual planning effort. Preplanning sessions for multiple AWACS coverage were often limited to AWACS tactics personnel with minimal input from key ICU players; consequently, an excellent planning opportunity was not fully exploited. Additionally, the use of multiple Tactical Digital Information-Link B (TADIL-B)) often caused confusion and led to misunderstandings between the ICU and naval data-link (Naval Tactical Data System (NTDS)), Airborne Tactical Data System (ATDS) participants. Overall architectures were briefed and discussed at the weekly Tactical Air Control System (TACS) meeting (attended by various liaison personnel), but a more comprehensive planning effort would have been possible had key players attended and provided input during initial planning sessions.

LESSON(S): Ideal conditions of collocation or close proximity of major interface participants may not always exist, but when they do, they must be exploited fully. This close association and group planning effort assures a unity of effort, eliminates conflicting priorities, and establishes a firm foundation for future operations when units are geographically separated.

TOPIC: Digital Data Link.

DISCUSSION: The capabilities of the 02 digital data-link interface were not fully exploited. Operation DESERT SHIELD had the most ambitious C2 and data-link interface ever attempted by U.S., North Atlantic Treaty Organization (NATO), and other Allied Nations. The data links employed included TADIL-A, TADIL-B, Army Tactical Data Link-I (ATDL- l), Tactical Digital Information Link-C (TADIL-C), and Interim JTIDS Message Specification (IJMS). These links, from appropriately equipped platforms, have the potential to reduce the need for voice communications among the various link participants and promote situation awareness among all elements.

Positional information and identification information for surface, air, and land targets are supported by the protocols and data elements within the message.

C2 operators and battle management personnel need to be aware of what link information is available to them and what types of information the various platforms can contribute to their situation awareness. Positional information, current status information, weapons status information, engagement status, weapons release, air raid warning and command orders are all available from the various links.

When voice reports or voice amplification of information already available from or to the links is required, the utility of the links is diminished. The interface participants' concern for discovering and developing information for voice reports detracts from the time needed to develop and transmit the same information or the same kinds of information using the data links.

LESSON(S): All data-link-capable C2 agencies must use the data links and data elements within the exchanged message protocols for enhancing the situation awareness of agencies above, below and adjacent to them. All data-link-capable units must ensure that they know and use the capabilities available to their agency on the digital data links. Interface units need to know how to effectively employ their agency in the best manner to enhance the situation awareness of the C2 interface; detect, track, and evaluate the threat; task, manage, and allocate friendly assets against the threat; and monitor the air, surface, and land situation displays.

TOPIC: Joint Army Airspace Command and Control (A2C2) Information.

DISCUSSION: The Air Tasking Order (ATO), Special Instructions (SPINs), and Airspace Control Order (ACO) were the key means to disseminate joint A2C2 information. Army aviation was not connected to the distribution system. The Air Force used the Computer -Assisted Force Management System (CAFMS) as its primary means of disseminating the ATO, SPINs, and ACO. Army aviation at all levels was disconnected from the Air Force distribution system. Forward deployed fixed-wing and helicopter units as well as echelon above corps (EAC) units operating from fixed based locations did not have ready access to CAFMS terminals. Vital mission data, such as mode I and mode II codes, time on target and station times, special electronic mission aircraft tracks, and air transit route approvals had to be obtained through secondary sources. Pertinent mission information was not obtained until after mission windows had been missed in some instances. From D-day forward, daily ATO, SPINs, and ACOs totaled more than 800 pages which made alternative distribution systems, such as Automatic Digital Network (AUTODIN), an impractical source for necessary information.

LESSON(S): Real-time access to critical airspace management information is virtually impossible for Army aviation units without connectivity with the Air Force CAFMS or any replacement systems. The Army must resource an automated system that has connectivity with the Air Force airspace management system.

TOPIC: Tactical Operations Data.

DISCUSSION: There was no Tactical Operational Data (TACOPDAT) in use or in force prior to the development and publishing of the Air Defense Plan and Airspace Control Order. The TACOPDAT message is used by the Area Air Defense Commander (AADC) to publish airspace control measures (ACMs) and the procedures to be used by the air C2 agencies to integrate surveillance, data link, voice, and C2. It is used to publish permanent changes to the operations orders. In the absence of an order or plan, the TACOPDAT can be used to disseminate the initial guidance necessary to accomplish air C2 through the various agencies.

An attempt to publish this information was made by including similar information in the SPINs portion of the Air Tasking Order (ATO). This attempt failed because the ATO SPINs is a free-form element in message format. The C2 agencies had to sift through multiple pages of SPINs to find the elements that were of importance to them.

LESSON(S): In the absence of a published air defense plan or airspace control order for a particular area of operations, a TACOPDAT message should be published at the earliest possible time to facilitate the establishment of airspace control measures, surveillance areas, and to set up the C2 relationships. Theater air control and air defense planners should consider developing a strawman TACOPDAT for their various operations plans prior to introduction in the theater. The TACOPDAT is used in conjunction with technical operational data (TECHOPDAT) to delineate the procedures to be employed by the command, control, and air defense agencies in a particular area of operation.

CHAPTER 2

COMMUNICATIONS

TOPIC: Frequency Management.

DISCUSSION: The current automated frequency management and engineering capabilities are inadequate to support the fast-paced tactical environment of Command, Control, Communications and Intelligence (C3I) equipment on the electronic battlefield. During major joint military operations, such as Operation DESERT SHIELD, radio frequency (RF) requirements quickly exceed the available frequency resource. The proliferation of RF C31 equipment, deployed on the battlefield, has created a potential situation for acute interference between mission critical C31 systems. Without the proper automated management and engineering tools used at the appropriate echelons of command, compatible battlefield frequency management cannot happen.

Frequency managers at the various echelons of command do not have the proper automated tools to manage their frequency resource or provide engineering support.

No capability exists to electronically transfer mission-essential frequency assignment data between echelons of command and service components.

Those few units with automated engineering tools were able to quickly engineer noninterfering RF systems, whereas the units without such tools could not.

LESSON(S): An automated capability is needed at the joint level which will subdivide the tactical frequency bands proportional to the service components' requirements. The Army needs a similar capability when deploying a multicorps force.

A capability is needed to electronically distribute frequency assignment data between echelons of command. The data transfer must be interoperable with existing service components' automated frequency engineering systems.

Automated frequency engineering tools are needed at corps and division echelons.

TOPIC: Intelligence Operations.

DISCUSSION: The communications architecture that supports intelligence operations is inadequate. Many tactical commanders' requirements for timely, detailed intelligence for planning and executing operations exceeded intelligence capabilities. Prior to G-Day, the U.S. Army component of USCENTCOM (ARCENT) and corps established communications, computer, and imagery links down to several divisions. Corps and several divisions received TROJAN Special Purpose-Integrated Remote Intelligence Terminal (SPIRIT) for secure Satellite Communications (SATCOM) (voice, data, fax) and Tactical Exploitation of National Capabilities (TENCAP) Tactical High-Mobility Terminals (THMT) and other Secondary Imagery Dissemination Systems (SIDSs) to receive intelligence data and products.

These systems had significant fielding and integration challenges. There were insufficient numbers of systems to provide each echelon with a dissemination capability. No brigade or below received a system. Furthermore, the systems did not provide adequate quality or quantities of hard-copy photos to satisfy commanders, necessitating reliance on couriers.

Once the ground war started, some commanders perceived that intelligence products from their higher headquarters became less frequent. They attributed this in part to communications problems. Retransmission assets and tactical satellite (TACSAT) lines were limited. The fast pace of the ground war and great distances between units caused problems in maintaining communications. Frequency modulation (FM) radio systems simply could not cover the distances between command posts, particularly while on the move. Consequently, intelligence updates were sporadic and seldom timely.

A robust communications architecture (equipment and personnel) must be deployed early to support the heavy message and data flow of intelligence information to and within a theater of operations.

Problems existed in the following areas:

- Connectivity from the Continental United States (CONUS) to theater.
- Connectivity within the theater among intelligence units.
- Connectivity within the theater to its fighting units (most important link).

LESSON(S): The Army must ensure adequate circuitry and communications security between echelons of command, both joint and combined, thereby enhancing the rapid dissemination of intelligence information.

TOPIC: Joint Intelligence Information Exchange.

DISCUSSION: Doctrine does not adequately address intelligence information exchange in joint and/or combined organizations. Operations orders sometimes do not clarify priorities or command relationships among joint intelligences (J2s). Intelligence collection units must understand their taskings and understand which J2 or G2s have priority of collection effort. The assumption should be made that a Joint Intelligence Task Force must be formed early to pull together the intelligence picture. Contingency plans (CONPLANs) and operation plans (OPLANs) should address this matter and modify intelligence structures to make implementation easy. Clarity of intelligence C2 is critical to the effectiveness of this task force. The Joint Intelligence Task Force must pull together the collection and production activities of the following:

- Service tactical assets.
- Theater tactical and strategic assets.
- National assets for tactical strategic use.

This is a difficult task. It involves hundreds of pieces of equipment and units and requires extensive manpower and equipment augmentation to be effective.

LESSON(S): In joint and combined operations, there must be a central command to pull together and maintain an accurate, up-to-date intelligence picture.

TOPIC: Data-Link Architecture Employment.

DISCUSSION: The data-link architecture was theoretically sound, but not always tactically sound. For example, Class I Joint Tactical Information Distribution System (JTIDS) terminals, using the Interim JTIDS Message Specification (IJMS) for jam-resistant data communications, were minimally employed by capable units. Although all participants in the interface were not capable of IJMS operations and others were in the process of obtaining an IJMS capability, the initial capability to exercise this very important option existed, but had not been adequately exploited. The plan to implement the IJMS option in the "D-DAY" configuration with available equipment had been discussed, but basically had not progressed beyond the discussion stage. As more required equipment arrived in-theater, it was introduced into the architecture piecemeal without an overall plan. Communications limitations (primarily high frequency (HF)) for data link and voice between ground and seaborne platforms and airborne platforms were degraded by atmospheric conditions, physical location of surface elements and a host of other factors. The automatic radio relay equipment (AUTOCAT) capability was expedited for Operation DESERT STORM and was used as a radio relay (U.S. Air Force EC-130 aircraft (VOLANT SOLO), Royal Saudi Air Force (RSAF) KE-3, RSAF E-3) when required. Although an interface plan may meet the necessary technical requirements and "should work," there are many factors outside the theoretical limits of equipment that impact the architecture. Taken separately, these factors may have minimal impact, but, in combination, they detract significantly from link performance of communications capabilities, equipment limitations, and threat assessment. Sound, in-depth planning and control by the Interface Control Unit (ICU) are absolutely imperative and should be continually provided as the interface evolves and matures.

LESSON(S): Jam-resistant data-link operations must be exploited whenever possible. Planning must be conducted to rapidly and effectively integrate additional equipment into the architecture. Also, reconfiguration and relocation of ground communications and antenna systems must be explored to improve reliability of data and voice communications between surface and airborne platforms. Finally, the radio relay (AUTOCAT) capability must be more fully exploited.

TOPIC: Communications Plan.

DISCUSSION: The communications plan as published in Operation DESERT SHIELD monthly special instructions (SPINs) was comprehensive, yet contained potential conflicts between data and voice frequencies and was extremely cumbersome to use. The entire communications plan was contained in the Operation DESERT SHIELD SPINs, but users had to leaf through or reference several pages to correlate required information, i.e., frequency, TADIL code, use, etc. Again, the information was there, but needed to be reorganized in an easier to use format to eliminate confusion by the user. Voice and data frequencies were basically deconflicted, but without considerable time-consuming research through the communications plan, users could select frequencies that did conflict, increasing the potential for system degradation and equipment failure.

LESSON(S): The communications plan needs to be reorganized with input from the user and concentration on user friendliness.

TOPIC: Range Extension.

DISCUSSION: Range extension communications assets in the division and corps are inadequate. The ranges/distances covered and the speed of movement reinforces the AirLand Operations requirements for range extension and the ability to perform C2 on the move. Extensive use was made of multichannel satellite, single-channel satellite, single-channel HF, and multichannel Tropospheric Scatter Path (TROPO) systems. These assets were over and above what the tables of organization and equipment (TOEs) for division and corps now have. Also, the mobile subscriber equipment (MSE) system mounted on High-Mobility Multipurpose Wheeled Vehicles (HMMWVs) was found to be capable of keeping up with fast-moving formations--much better than earlier systems.

LESSON(S): Relook the TOE of divisions and corps to consider the requirement for range extensions communications assets. This should be done as a part of organizational considerations in developing air and land operations force structure.

TOPIC: High Frequency (HF).

DISCUSSION: HF communications for voice and data were difficult throughout the region. The distances involved, the types of terrain to negotiate, atmospheric conditions, antenna site selection and other factors combined to make HF communications for voice and data extremely difficult. The Interface Control Unit (ICU) cell used a number of different types of HF radios and antenna configurations.

During operations there was a dependence on HF communications, either voice, data or both, to maintain connectivity within the data interface. Stations that were capable of it were tasked to simulcast on ultra high frequency (UHF), HF, and JTIDS Class I terminals in an effort to get communications redundancy into the data links.

This redundant approach worked. Both UHF and the JTIDS Class I operations worked well for line-of-sight operations. Operations that were conducted out of line-of-sight had to be accomplished by HF means.

LESSON(S): All participants in voice and data nets must expend the effort and take all the precautions necessary to enhance successful HF voice and data transmission and reception. They must:

a. Guard against self-induced Electromagnetic Frequency Interference (EFI) problems by making sure there are no ungrounded wires, brackets, or other carriers in or around HF radio equipment to cause secondary radiations.

b. Keep HF voice and data radio emitter power levels at a minimum.

c. Maintain I 0-IS percent frequency separation (3 megahertz (MHZ)) between adjacent transmitters to guard against costly equipment failure and serious signal distortion caused by receiver desensitization due to Radio Frequency Interference (RFI).

d. Ensure that the Doppler correction function is enabled in TADIL-A-capable units to guard against a change in frequency caused by the relative motion among link participants.

e. Ensure, for each HF receiver, the Automatic Gain Control (AGC) attack time is properly set to guard against TADIL-A data reception problems.

f. Guard against multipath interference by ensuring that the antenna is free from masking by large structures.

g. Enhance the possibilities for uniform propogation (no dead spots) by emplacing, erecting, and conducting regular preventive maintenance on antenna systems.

TOPIC: Precedence Allocation.

DISCUSSION: Precedence allocation within the tactical circuit-switched network was excessive and resulted in unacceptable call completion rates. JCS Pub 6-05.7 tactical telephone subscriber precedence allocation criteria was not followed by the components. JCS Pub 6-05.7, Page 34-I, lists the following precedence allocation criteria as a guideline:

Flash Override:----------0.2 Percent

Flash:--------------------2.0 Percent

Immediate:---------------4.5 Percent

Priority:-----------------27.8 Percent

Routine:-----------------65.5 Percent

During the early stages of the Operation, a review of circuit switch traffic-metering reports indicated that precedence abuse was prevalent throughout the entire theater. The criteria listed above was adopted as policy and disseminated to all component System Control Stations (SYSCONSs) via message for review and enforcement. A subsequent review of traffic metering indicated that precedence allocation was still excessive. The determination was made that the only subscriber in the network that would be authorized the FLASH Override precedence would be the Commander in Chief (CINC). This decision then became policy and was transmitted via message to component Chiefs of Staff for review and enforcement.

This problem was further compounded by the Mobile Subscriber Equipment (MSE) Preaffiliation List precedence allocation. The MSE software, initially brought into the area of responsibility (AOR), had excessively high subscriber precedence authorizations. At times, high precedence MSE calls dominated the MSE and joint tactical communications (TRI-TAC) gateways. In several instances, high precedence MSE calls also dominated the TRI-TAC gateways into the theater and direct support maintenance (DSM) networks.

Lastly, this problem was compounded by the fact that there currently is not a mechanism that allows an MSE Preaffiliation List to be modified in theater in a timely manner. A new list had to be developed in CONUS and shipped to the AOR which resulted in a delay in achieving the desired theater call completion rates. As with DSN access, precedence allocation is not an unlimited resource. Trunk group cluster sizing and precedence allocation must go hand in hand. The G6 and J6 Staff Officer is charged with the validation of subscriber requirements, a subset being precedence authorization. He must coordinate closely with the network manager to ensure that subscriber precedence does not adversely affect the circuit switch network's overall performance.

LESSON(S): Precedence allocation, throughout the entire theater, must be closely monitored and managed at the Theater level. Current precedence allocation criteria, as listed in JCS PUB 6-05.7, is not stringent enough in a real-world hostile environment.

CHAPTER 3

INTEROPERABILITY

TOPIC: Joint Tactical Communications (TRI-TAC).

DISCUSSION: Echelons above corps (EAC) communications equipment (TRI-TAC) performed well, but was not available in Force Package 3 units. The communications network consisted of a mixture of several different technologies and architectures, resulting in the largest automatic switched voice and message network in the history of the U.S. Army. The multiplicity of equipment, different architectures and the analog and digital mix found in the operational force structure was bridged through the flexibility and interoperability of TRI-TAC equipment systems. This equipment was totally interoperable with the Improved Army Tactical Area Communications System (IATACS) at division level, Mobile Subscriber Equipment (MSE) at division and corps levels, the TRI-TAC family of equipment found at corps and theater levels and a myriad of strategic systems which linked combined and joint tactical headquarters with all deployed units as well as the National Command Authority. Older generation EAC communications equipment is not nearly as flexible.

EAC Reserve Component (RC) units are not currently scheduled to receive full sets of compatible TRI-TAC equipment. Force Package 3 units that were not equipped with, or trained on, compatible TRI-TAC equipment were deliberately deleted from the force list during Operations DESERT SHIELD and DESERT STORM.

Major components in the EAC TRI-TAC network, such as the AN/TTC-39A Automatic Circuit Switch, are scheduled for modification but funded only for the Active Component (AC). The result of this approach will be that AC and RC capabilities at EAC will become more disparate over time and RC units will not be able to be integrated into the theater network.

Failure to modernize RC units at EAC to the same level as the AC will eliminate the capability to create a robust network and eliminate the assets required to reconstitute the network on the battlefield.

LESSON(S): Continue to field EAC TRI-TAC communications equipment and continue the modification in-service program, striving for interoperability and flexibility, facilitating the development of robust and reconstitutable networks.

Review and adjust the RC Modification Plan to ensure RC units are equipped with TRI-TAC communications systems which are compatible with the active force in planned areas of operations.

TOPIC: Data-link Architecture Critical Nodes.

DISCUSSION: Initial data-link architecture relied very heavily on critical nodes, which, if inoperative, "crashed" the entire interface. Data-link architecture in the initial stages of Operation DESERT SHIELD consisted of a single TADIL-A net which, by design, relied too heavily on certain critical nodes for TADIL conversion and data forwarding in the terrestrial portion of the architecture. This critical node dependence often crashed the entire interface during equipment outages or when communications problems arose. Possible solutions were often discussed at the Interface Coordination Unit (ICU) but were seldom preplanned with interface participants and were, therefore, time-consuming and difficult to implement. The data link should be designed to reduce critical node dependence, especially in the terrestrial data conversion and forwarding network. By breaking the interface into multiple TADIL-A nets with multiple entry points into the terrestrial structure, the interface becomes more manageable and node outages can be worked around. At the very least, when outages occur, the entire interface is not scrapped. Additionally, solutions and contingency plans must be worked well in advance and briefed to all interface participants responsible for data conversion and data forwarding.

LESSON(S): A single TADIL-A net, while desirable under certain circumstances, relies heavily on certain critical nodes for display and dissemination of the air picture. In an architecture on the scale and scope of Operation DESERT SHIELD, and given the environment, it is imperative that critical node dependence be reduced as much as possible.

TOPIC: Data-Link Architecture Flexibility.

DISCUSSION: The initial data-link architecture did not exploit existing capabilities to allow rapid reconfiguration when outages or equipment availability affected operations. Adequate communications paths and sufficient data forwarders from both the USAF and USMC were in place to support various configurations for TADIL conversion and data forwarding; however, initial interface design and contingency planning did not take full advantage of this inherent flexibility. Often, required reconfigurations were spur-of-the-moment unilateral actions, and changes were made in the terrestrial architecture without the full knowledge of other participants. While these changes sometimes worked, the transition would have been much smoother with prior contingency planning and exercising of preplanned options. Additionally, reconfigurations usually have a "ripple effect" throughout the interface and if not directed by, at least they must be approved by, the Interface Control Unit (ICU) prior to implementation. Planners should focus not only on primary configuration but also on secondary and tertiary options during the data-link architecture design process. Once this has been done, the potential options must be briefed to, and understood by, all affected participants. Implementation of any option, primary or otherwise, should only be done at the direction of the ICU.

LESSON(S): Interface architecture design must take into account the TADIL conversion, forwarding and communications capabilities of interface participants with regard to backup or contingency planning. While the initial interface was basically sound in theory, it was cumbersome and did not reflect a high degree of built-in flexibility.

TOPIC: Airborne Early Warning and Control System (AWACS) Communications Conversion.

DISCUSSION: There is no conversion of information received at the AWACS via Joint Tactical Information Distribution System (JTIDS) Class I terminals and TADIL-A and vice versa. The AWACS was tasked to participate in both TADIL-A Operations and JTID S Class I operations simultaneously. Any information transmitted to the AWACS via TADIL-A was not transferred to the JTIDS Class I network in which the AWACS was participating. Conversely, any information received by the AWACS via JTID S Class I terminal was not translated to the TADIL-A network and rebroadcast via that medium. Greater versatility with data exchange could be realized if the JTID S information and the TADIL-A information could be exchanged within the AWACS and transmitted via other mediums.

LESSON(S): There is no data conversion and translation between information received via JTIDS in the AWACS and translation for transmission on the TADIL-A net. Conversely, information received via TADIL-A in the AWACS is not available for conversion and translation to the JTIDS net. The information received by the AWACS must be translated and made available for transmission via different types of medium. Acquisition of this capability would enable the AWACS to share its information from all data-link sources with all other data sources available to it.

TOPIC: Corps Tactical Area Signal Center (CTAS).

DISCUSSION: The CTASC-II fielded in support of a corps was fielded with 9.6kb modems that could not be readily used to communicate to the Defense Data Network (DDN) over the tactical communications systems. The CTASC-II was fielded into theat to communicate to the DDN using a KG-84 (secure device) and a 9.6kb modem. The TRI-TAC communications systems employed by the signal brigade could not transmit data at 9,600 baud through the TD-660s used in the multichannel radio systems.

Although the TD-1069 and TD 1065 combination was available to pass low-speed data through the high-speed data buffer, bypassing the TD-660, the signal brigade was unable to get this equipment to operate reliably.

The CTASC-II was connected to the DDN using KG-84s over the tactical communications system. The KG-84s were set up to communicate a conditioned diphase synchronous signal at 32kb. The KGs were not used for their ability to encrypt data but for their modem which, at 32kb, would bypass the TD-660s and use the TD-1065s in the multichannel systems, thus providing a high-speed path for the Class "B" host to communicate to the DDN gateway. The circuit path goes from the binding posts of the CTASC-II via WF-16 wire to the binding posts of an AN/TRC-I51. The AN/TRC-15I goes to another AN/TRC-I5I at a relay where it goes to an SB-675 Patch Panel via 26-pair cable. From the SB-675 it goes to an AN/TCC-73 via PCM cable. The AN/TRC-138 goes to another AN/TRC-138 where it goes to the AN-TCC-73 over PCM cable and then to an AN/TSQ-84 Tech Control via 26-pair cable where it is strapped over to another AN/TRC- 151 system via 26-pair cable. The AN/TRC- 151 at the DDN Gateway location was cabled via 26-pair to the ISC patch and test facility.

As a note, the binding posts on the CTASC-II had transmit and receive reversed. This seemed to be consistent throughout the entire assemblage. It appeared as if the shelter was designed from the perspective of the transmission system connecting to it as opposed to it connecting to the transmission system.

The CTASC-II requires a synchronous link between the Unisys 5000 and the Cisco Gateway; the KG-84s lost sync when the communications link became marginal or took a "hit." This "sync loss" stopped data transfer between the host and the gateway and required the KG-84s to be reinitiated by flipping the momentary initiate switch on the front of the KG-84. Because the reinitiation of the KG-84s required operator intervention, the decision was made to use Crypto Reset Units (CRUs) to monitor and reinitiate the KG-84s automatically when an out-of-sync condition was detected. The CRUs were obtained out of salvage from Germany through the PM TACMIS office for use in Operation DESERT SHIELD.

LESSON(S): Document and implement a method for connecting the CTASC-II to the Defense Data Network over the tactical communications system. If KG-84s are to be used, Crypto Reset Units should be considered for installation into the CTASC-II to maintain the synchronous link.

TOPIC: Common Hardware/Software.

DISCUSSION: The lack of a standard theater-wide computer hardware and software suite prevented the timely exchange of tactical transmission system, circuit switch, and message switch data bases, reports, and diagrams. The hubs of the TRI-TAC Architecture are the AN/TTC-39 Circuit Switch and the AN/TYC-39 Message Switch. It should be noted that the first message switch was fielded 10 years ago. Tactical transmission systems, circuit switches, and message switches revolve around detailed, and sometimes lengthy, detailed data bases. It is these detailed data bases that "tell" transmission or switch hardware and software how to respond to a given set of conditions.

The objective TRI-TAC network planning and management tool is the Communication Systems Control Element (CSCE) which underwent, and successfully passed, a User's Acceptance Test in July 1990. The CSCE supports the Army's three-tier, (node, battalion, brigade) philosophy of TRI-TAC network planning and management. It accomplishes this by providing a "shared network-wide data base" at each of the three network management echelons. Due to physical size considerations, the Air Force and joint community chose not to adopt the CSCE as their network planning and management tool.

The Air Force and joint community have adopted the Tactical Network Analysis and Planning System (TNAPS) as their interim solution to assist in TRI-TAC network planning and management. TNAPS is a computer software applications program which resides on a desktop computer. TNAPS assists in the development of the detailed transmission system and switch data bases. TNAPS is a stand-alone system. The following organizations were responsible for planning and managing their portion of the overall tactical communications switched network:

(1) CENTCOM

(2) CENTAF

(3) ARCENT

(4) MARCENT

(5) 11th Signal Brigade

(6) 35th Signal Brigade

(7) 93d Signal Brigade

(8) JCSE

Each of these organizations used the tools which they felt most comfortable with to assist in data-base development. These tools included, but were not limited to, TNAPS, word-processing software, and, in some instances, "stubby pencils." Had any one of the organizations responsible for network planning and management been forced to delegate their responsibilities to a subordinate organization, it would not have been without considerable difficulty. As it was, little or no network planning and management products were exchanged electronically between the various organizations. This lack of timely information exchange resulted in:

(1) Inconsistent Circuit Routing Lists

(2) Inconsistent Circuit and Message Switch Data bases

(3) The Lack of a Theater Tactical Telephone Directory

(4) The Lack of Accurate Theater-Level Network Diagrams

LESSON(S): The lack of a shared network-level data base resulted in the tactical communications switched network performing at a marginal level, and provided inadequate subscriber support. The Joint Staff must mandate required data and format an electrical interchange of any tool that will assist in TRI-TAC network planning and management. The capabilities, characteristics, limitations, and applications of this tool must be articulated in JCS Pub 6-05.7 and be included in service-school curriculums.

TOPIC: STU-III Telephone.

DISCUSSION: Common Hardware Software (CHS) data communications over STU-III using the MS-DOS coprocessor and Smartcom III software were successful. CHS data communications over STU-III from the UNIX environment using Kermit software was also successful, but considerable difficulty was experienced configuring the RS-232C port from the UNIX environment. If the RS-232C data ports were first configured from MS-DOS, then data communications over STU-III using UCCP or Kermit were successful. Configuration of the RS-232C port from the UNIX environment to support STU-III data communications remains under investigation.

LESSON(S): STU-III communications were successful.

TOPIC: Corps Tactical Area Signal Center Protocol.

DISCUSSION: The CTASC-II, although designed for subordinate Division Materiel Management Centers (DMMCs) to communicate directly from its Tactical Army Combat Service Support Computer System (TACCS) to the CTASC-II, was unable to do so because the software (Monitored Asychronous Protocol (MAP)) for the UNISYS 5000 was not available to communicate to the internal dial-up modems of the CTASC-II. Ideally the CTASC-II would have a number of common user telephone circuits terminated to its binding posts on the side of the shelter. These common user phone circuits would be connected to either the 16 rack-mounted V-23 modems, the TA-1035 telephone, the two KY-68 telephones, or the STU-III telephone, the two KY-68 telephones, or the STU-III telephone. From there the phones would be connected physically to the UNISYS 5000 running a UNIX version of the MAP software. The DMMCs and Nondivisional Units would use their TACCS, communicating whether through the 212 Modem over two-wire analog circuits, or a digital telephone, such as a TA- 1035 or KY-68, using the digital interface cable supplied with the TACCS, to the CTASC-II. Using the MAP software at both locations, the Direct Support Units (DSUs) would transfer their requisitions to the Materiel Management Center (MMC) and could also receive status on existing requisitions passed.

With the MAP for the CTACS-II Computer itself not supplied, this method of operation could not be used. In addition, there were other problems with the MAP being used on the TACCS by the DSUs and the failing of the units (MMC and DSUs) to request the communications lines for the CTASC-II and TACCS at their locations. Further investigation revealed that the reasons for not requesting the lines were two fold:

a. In the case of the CTASC-II, it was known that MAP for the UNISYS 5000 was not supplied. In addition, this was the first time the CTASC-II was ever taken to the field.

b. In the case of the DSUs it was discovered that several units had never used this method to transfer data. During unit exercises, although the TACCS was taken to the field, the supporting data processing activity (DPA) that processed the data from the DSUs remained in garrison. This provided an opportunity for soldiers to return from the field and take care of personal business while they turned in their diskettes to the DPA.

This mindset caused the DSUs to never request phone circuits for their TACCS, and, as a result, they were never included in the signal planning. Those that did request a phone line would often Find their phone line connected to an instrument on another desk. Telephone requirements for Logistics support had been pre-empted by "higher priorities."

The solution for this particular situation was to have a TACCS "front end" to the CTASC-II where units would take their magnetic media to the MMC and turn it in to the Logistics Automated System Support Office (LASSO). The LASSO would load the diskettes into a TACCS that was connected to the CTASC-II via fiber optic or RS-232 cable; they would then be loaded into the CTASC-II. This still required the DSUs to take media to the MMC instead of using the available communications system to transfer the data electronically as designed.

LESSON(S): Provide the necessary software for the CTASC-II to communicate, as designed, to TACCS using the process of dialing over the common user phone system into CTASC-II. This procedure will directly support the processing of supply actions.

TOPIC: Monitored Asynchronous Protocol (MAP).

DISCUSSION: Use of the MAP with the TACCS proved unsatisfactory over tactical communications in terms of speed and ease of use. In a test transmission between an aviation brigade and the MMC, MAP was unable to "handshake" over the tactical communications line. MAP appears to be highly sensitive to line quality. An intermittent interruption in service causes the protocol to reinitiate the handshaking sequence. MAP would begin the process and once the circuit took a "hit" where a burst interfered with transmission, MAP would have to start again initiating communications and start transmission all over again. With some of the marginal communications lines from the outlying units, MAP could be handshaking for hours. This frustrating sequence of events would cause units to lose confidence in this means of transferring data and they would rely on taking magnetic media to the MMC. The design of MAP where it interacts with applications on the TACCS to provide a number of transactions files for processing has proved cumbersome from a management perspective. It forces processing of all the transactions once transmission starts before another can begin. This impacts how long a unit is communicating over the common user phone system and how fast the MMC can process customers.

The relationship between MAP and the Standard Army Retail Supply System (SARSS) forces customers to remain on-line for a long time while processing of the data takes place (i.e., the processing of incoming data to produce several files to process). In addition, the files that are being transferred are always the same names from unit to unit which means that the application must complete processing one unit's data before it can start transferring another unit's data (files will be over-written). A unit's files could be uniquely identified (perhaps by Department of Defense Activity Code (DODAC) and unit identification code (UIC)) so that the application could process them in batch off-line and still maintain the unit and file(s) relationship. In this way a process running in the background could process the data files in batch while still allowing other activities to communicate and transfer data at the same time.

A solution used to increase capacity to transfer data to the data processing activity (DPA) during the early stages of deployment worked as follows:

a. DPA would receive data files on MS-DOS diskettes from DSUs and compress them into one file using PKZIP. This file would be given a unique name.

b. The compressed file would then be transferred to the DPA using Z Modem and personal computers (Zeniths at both locations) where it would be expanded using PKUNZIP.

c. The DPA would then process the data in batch off line without restricting the incoming flow of data.

d. A status would be returned to the unit in the area of responsibility (AOR) using the same method.

LESSON(S): Use of MAP in its current form should be curtailed. Another program for transferring data should be used which is more tolerant of poor quality communications lines as is sometimes found in a tactical environment. Consider a communications program which employs some type of error correction, such as the Microcom Network Protocol (MNP) to establish a "reliable" communications link and still allow protocol data transfers, should be considered.

The link between the SARSS applications and the MAP should be resolved so that some amount of flexibility can be provided the managers of a DPA in processing data. The MAP really "ties the hands" of the LASSO as it attempts to service requests and updates status of its customers.

TOPIC: Inter-theater COMSEC Page (ICP).

DISCUSSION: Communications between unit boundaries was a problem. The use of an ICP throughout the duration of the battle was a necessity. Keying material was made unreliable to both of the Corps. This keying material is designed for temporary use until units are in place. A theater-wide key code is needed for Flight Operations Center and Flight Coordination Center (FOC and FCC) operations to allow aircraft communications from one boundary to another.

LESSON(S): A joint net needs to be established in the very early stages of pre-war operations, then allowed to continue in use until a cease fire has been called.

TOPIC: Technical Operational Data (TECHOPDAT) Development.

DISCUSSION: Technical pre-arranged data items are developed by the C2 agencies to connect their units via data links. Development of these data elements, to be published in a formatted message (TECHOPDAT), should be done with several important factors in mind. The TECHOPDAT is a U.S. Message Text Format (USMTF) message used to publish technical prearranged data items necessary to link suitably equipped C2 platforms.

a. The originator as well as the units responsible for executing the TECHOPDAT have a responsibility to each other for production, dissemination, and implementation. The TECHOPDAT is formatted in such a way to enhance the readability and understandability of the entries necessary to establish, activate, and manage the TADIL-A, TADIL-B, and Interim JTIDS Message Specification (IJMS) data-link networks.

b. The originator of the TECHOPDAT should solicit from all of the participants in the interface, information concerning the technical parameters that affect their system operation. These inputs include, but are not limited to, the following:

(l) Number and types of data links that a unit can operate with at the same time.

(2) Any known restrictions associated with Participating Unit (PU) or Reporting Unit (RU) assignments for a particular unit.

(3) Any known restrictions associated with selection of a Data-link Reference Point (DLRP) for a particular unit.

(4) Any known limitations affecting the display capabilities for a particular unit.

(5) Any known track number block assignment limitations including minimum and/or maximum number of tracks to be assigned, upper and lower limits of track number block assignments.

(6) Organic and nonorganic communications media available to the data-link participant to include Ground Mobile Forces Satellite Communications (GMFSATCOM) access, HF, UHF radio availability for voice and data circuits, cryptographic equipment and keying material availability at a particular unit, and secure voice communications available at a particular unit.

c. Based on the inputs received from the participating units, the originator should then produce a document listing all the information and coordinate it with all of the participants.

LESSON(S): The command responsible for developing and publishing the TECHOPDAT must be sensitive to the needs of all of the interface participants and develop the TECHOPDAT using inputs from all of the potential users of the technical prearranged data items. The following must be considered and included in the TECHOPDAT:

(l) Develop a plan for allocating PU numbers. Group-like platforms within the same numbers or types of numbers (e.g., Eastern Navy Ships PU30-40, Western Navy Ships PU 41-55, Allied Platforms PU 01-07, AWACS PU 10-17, etc.)

(2) Pool track number blocks whenever possible.

(3) Assign continuous track number blocks to like platforms or a single service. Adjustments to these track number blocks can be easily accommodated.

(4) Do not complicate the assignment of code words for DLRP, control points, and frequencies.

(5) Maximize the use of standard joint terminology in narratives.

(6) Carefully select Data-link Reference Points that support the operation and expected direction of movement.

(7) Use check-sum digits whenever possible.

(8) Produce a draft TECHOPDAT that can be reviewed for completeness and applicability by all participants. If possible, give all of the participants, or a knowledgeable representative, sufficient time to review the draft, develop corrections, and return the corrections to the final product.

(9) Ensure that the Plain Language Addresses (PLADs) and Routing Indicators (if required) are correct.

(10) Begin developing the next TECHOPDAT as soon as the one that is in use is effective. Development of the technical prearranged data items is continuous until the end of the operation.

TOPIC: Technical Operational Data Input.

DISCUSSION: Input to the TECHOPDAT must be coordinated at unit level prior to submission to ensure that the personnel responsible for developing the technical prearranged data items for the C2 interfaces have current and accurate input. There was an extensive C2 interface using many different ground, airborne, and surface agencies. The number of participants, their capabilities and limitations and other factors was quite extensive. To properly develop the interface, a substantial set of parameters had to be managed. Once all of the various factors were considered, a TECHOPDAT was then published.

The TECHOPDAT was used by all of the interface participants to initialize their individual systems and link them via digital data in various configurations. Each of the systems had various parameters to take into consideration. Development of this extensive set of prearranged data items was quite tedious. The TECHOPDAT must be written using the following factors:

a. What is the overall guidance from the Area Air Defense Commander regarding the interface?

b. What inputs have been made by the user units regarding their needs for specific types of information?

c. What are the capabilities and limitations of the interface participants with respect to achieving the interface goals?

d. How can the interface participants contribute toward achieving the goals of the interface?

e. Are there any special considerations necessary for one unit or platform or type of platform?

f. Have the user units provided written input to the Interface Control Unit (ICU) to be used in producing the TECHOPDAT; has input been coordinated at unit level prior to submission?

LESSON(S): Inputs to the TECHOPDAT should be fully coordinated within the user units prior to hardcopy transmission to the agency responsible for producing it.

TOPIC: Joint Tactical Air Operations Training.

DISCUSSION: The education and training received by members of the CENTAF Air Defense Staff did not adequately prepare them to plan and execute Joint Tactical Air Operations (JTAO) interface operations of the scale required for Operation DESERT SHIELD. The size of the area of responsibility (AOR) and the variety of data link capable units presented the CENTAF Air Defense Staff with a planning and execution situation never before experienced. Traditional training has not addressed the need to integrate such large numbers of participants with varying capabilities into a single interface. This action required a much more detailed knowledge of system capabilities and a greater range of experience in data-link architecture design than is normally available in an Air Force Component Headquarters.

LESSON(S): Tactically sound data-link architecture in support of the JTAO interface requires detailed planning using factual information on the system capabilities of all expected participants. If the education and experience of the planning staff does not match the requirements, ask for assistance early in the planning phase. Increase the level of participation by component air defense staffs in the CINCFOR JTAO Interface Training Program.

TOPIC: Air Defense Communications Flexibility.

DISCUSSION: Army air defense units are limited in their communications flexibility for JTAO. Air defense units (HAWK and PATRIOT) are limited in the number and type of voice communications the console operators have available to them. This limitation hampers their effectiveness towards joint interoperability in JTAO. There are four voice circuits that are employed in conjunction with the JTAO data links. Voice communications drops in the AN/TSQ-73 and the PATRIOT Interface Coordination Circuit (ICC) are sufficient to support Army-only need lines. The additional voice circuits that support JTAO have to be routed through various instruments rnto the shelters supporting air defense (AD). The four additional voice circuits for JTAO are generally placed on instruments that have a handset attached to them. These additional handsets have to be constantly monitored by personnel in the Army AD shelters. It is inconvenient for the operators to hold these handsets or monitor these instruments that are not routed through the communications panel of the AD equipment. The AD joint voice circuits do not receive the same attention as circuits routed through the communication subsets.

LESSON(S): Careful consideration must be given toward making equipment available to Army AD units that will participate in JTAO data links. The communications capability at Army AD units is severely limited and does not support the four-voice circuits required for JTAO data-link activity. Changes to the communications subsystems should be made so that they can be configured to support the four voice circuits required for JTAO data-link activity.

TOPIC: Air Defense Communications Encryption.

DISCUSSION: Army air defense units that have a TADIL-B capability do not have compatible TADIL-B encryption and decryption capability. Army air defense units are configured for bulk encryption; all other services with a TADIL-B capability are configured for single-channel encryption. Air Force and Marine Cons TADIL-B-capable units use end-to-end encryption (single channel) to cover the TADIL-B link. Army air defense units (AN/TSQ-73 and PATRIOT) do not have this capability. These units rely on bulk-encrypted multichannel UHF systems for primary tactical communications. These UHF directional systems do not have an inherent single-channel encryption capability. Procedures exist to integrate Army AD units into the JTAO interface. However, if the proper equipment is not available, establishing a TADIL-B data link between Army air defense units and any other JTAO elements is greatly complicated.

Doctrinally, Army units provide the communications connectivity to the Air Force Control and Reporting Center (CRC), Control and Reporting Process (CRP), and Message Processing Center (MPC) source by collocating a directional UHF system and connecting it to the TADIL-B source with a special shielded cable. Interfacing Army air defense systems with Marine Corps TADIL-B sources is more difficult. No special cable exists to connect an Army system directly to the Marine Corps TADIL-B source. Single-channel encryption devices have been acquired for some Army AN/TSQ-73 sections which are interfaced using locally fabricated connecting cables. For PATRIOT operations, other arrangements have to be made. PATRIOT units can either have their TADIL-B signal routed through an appropriately equipped AN/TSQ-73 or fabricate cables to interface the TADIL-B encryption device inside their system. During contingency operations, and when a rapid response is required, the amount of effort required to integrate Army air defense units into an Integrated Air Defense System (IADS) is considerable. This effort could be reduced or eliminated if data encryption devices used by the Army air defense systems were compatible and interoperable with all of the other agencies that already have the proper equipment. Army air defense data encryption devices must be installed to provide compatible, interoperable equipment to Army units capable of conducting TADIL-B. Single-channel encryption using KG-30s is used by all other services and agencies capable of TADIL-B operations. Bulk encryption is employed only by Army air defense units.

LESSON(S): Army air defense HAWK and PATRIOT units that are not properly equipped for Contingency Joint Operations must have sufficient training to use the procedures to enter the JTAO interface. Then existing equipment must be improved for incorporation of encryption devices that the other services have already placed in service.

TOPIC: Data-link Equipment.

DISCUSSION: Commanders purchased Joint Tactical Air operations (JTAO) data-link equipment for their units that was not certified for use on the joint interface. In the past few years, there has been a proliferation of JTAO data-link-capable equipments that have not been certified for use on the joint interface. Examples of this equipment are AN/TSC-110 Adaptable Surface Interface Terminals Joint TAD IL-A Distribution System (JTADS), Data-link Set, Portable Configuration (DLS-PC), and similar names for JTAO data-link-capable equipment .

When personnel are detailed to plan for their insertion in the data-link architecture, interoperability cannot be assured. These systems are generally purchased for contingency operations or rapid response usage. When acquired, their use was predicated on the assumption that no certified systems were available for interface or the scope of operations was such that certified C2 agencies would not be employed. Whether intended or not, they will invariably be used by units to meet the requirements of a tactical situation when no other alternative is viable.

Data-link equipment has the capability to participate in TADIL-A or TADIL-B or ATDL- 1. They also can be used to feed C2 agencies. When data-link anomalies or errors occur in the certified systems, it is very difficult to determine both the cause of the errors and develop workarounds to solve the problems. These "quick-fix" systems have unknown implementation of the TADIL standards and may not behave in a predictable manner with other certified equipments or agencies. Development of JTAO data-link architectures and troubleshooting of the links is complicated by not knowing the TADIL implimentations of these systems.

LESSON(S): Special-purpose equipment procured outside of normal acquisition channels must still be subjected to configuration control standards. The agencies responsible for proponency of these systems, and proponency for their users, must establish procedures for configuration control of these systems.

TOPIC: Computer-Assisted Force Management System (CAFMS).

DISCUSSION: CAFMS reporting requirements cannot reasonably be accommodated by Army Aviation units. Joint Force Air Component Commander (JFACC) controls theater airspace and assigns missions above the coordination altitude in the daily Air Tasking Order (ATO). Army aircraft must be included in the ATO to fly missions above the coordinating altitude. The CAFMS is the primary means of transmission for the ATO and airspace instructions. It is also used by USAF units to report flight mission information back to the Tactical Air Control Center (TACC). It is a two-way communication system for mission and airspace. The Army units below corps headquarters do not have CAFMS equipment, but are still expected by JFACC to keep up with airspace measures, mission changes, and to report mission information through the CAFMS. Noncompliance with changes is dangerous and not reporting through the system can result in airspace requests, for subsequent periods, being rejected. In essence, some Army Aviation units are forced to operate in a system without adequate equipment. Army Aviation units were forced to collocate or commute daily to Air Force units which had CAFMS terminals to input and extract mission information necessary to fly in theater airspace.

LESSON(S): CAFMS equipment must be supplied to Army Aerial Exploitation and fixed-wing units which must comply with the system. Develop a new system which will incorporate the Army units which fly in airspace above coordination altitude.

CHAPTER 4

INTERFACE CONTROL UNIT (ICU)

TOPIC: Joint Tactical Air Operations (JTAO)Interface.

DISCUSSION: Data-link operations for a theater-wide employment of the interface require timely and accurate feedback to properly manage the interface and maximize its performance. The employed JTAO interface involved many participants, with many different link capabilities and challenges over a large geographic area. The challenges are many with respect to organizing, managing and employing all of the participants to maximize their capabilities. All of the participants faced the prospect of not having their system capabilities maximized. When these cases occurred, it was difficult to explain to personnel responsible for interface management, the nature of the problem, and some possible solutions.

One possible solution to this situation is to have interface units publish a link summary report. This report could be used to make timely and accurate feedback to the Interface Control Unit (ICU) and personnel responsible for planning the link or managing the link could be used to make timely and accurate feedback.

Interface units that were able to use this capability maximized their contribution to the interface. They had a form for inputting their desires for the next period of operations. They were able to detail interface problems or problems that they were having with a particular portion of the interface.

LESSON(S): Timely feedback to the ICU can improve the overall quality of the data-link interface. Daily link summary reports must be forwarded to the ICU from all of the link-capable units. If necessary, a consolidated report from a Task Force, Task Group or an identifiable entity could be used to reduce the volume of message traffic. Information included in the link summary report should include:

a. The interface unit designation (i.e., Tactical Air Operations Center (TAOC), AWACS, etc.).

b. Program version used by the unit.

c. The TECHOPDAT date-time-group used and any changes received.

d. Directly tied units or TADIL-A net participants with which the unit is linked.

(l) Type of link.

(2) Time of link operations.

(3) Time of significant link outages and possible reasons for the outage.

(4) Crypto keymat used for link operations.

(5) Voice circuits employed for link operations.

(6) Any feedback desired to be used by the ICU for future operations.

The ICU, based on the link summary reports, provides hardcopy feedback to the interface participants. The feedback should include ICU impressions on the success of the operation and additional information that could be included as guidance or instructions on any future operations.

TOPIC: Joint Tactical Information Data System (JTIDS).

DISCUSSION: Significant problems were encountered by the ICU when attempting to implement JTIDS network operations among JTID 5-capable units participating in the joint interface. The JTIDS network parameters initially developed and published for use in the area of responsibility (AOR) were incorrect. There were no personnel in-theater (except for one technical representative working at the Control and Reporting Center (CRC) knowledgeable in JTIDS network design and terminal initialization parameters. This lack of knowledge resulted in numerous attempts to make the system work by modifying various timing and initialization parameters without full knowledge of the consequences. This situation was finally corrected by contacting the JTID S Program Office and requesting assistance. Support provided by HQ, ESD TCD-4, was timely. It was able to validate the network configuration that had been developed in-theater and recommend additional terminal initialization settings that improved the performance of the links. ClNCFOR should establish a working group to assess the current method of teaching JTIDS Class I network design and operation for all users. The focus of the assessment should be on defining the operational level at which this knowledge should reside.

LESSON(S): Employment of any tactical data system in real-world operations must be supported by trained planners and operators. Attempting to trouble-shoot network operations from remote locations is extremely difficult and is usually unsuccessful.

TOPIC: Voice and Data Configuration.

DISCUSSION: Many of the interface participants did not have a clear understanding of the various configurations available for data-link interface. A complex data-link interface was employed for Operation DESERT SHIELD. Both joint and combined forces were employed in a number of different voice and data configurations to form a C2 interface. Visualization of the interface is nearly impossible without the development of aids to understand the communications connectivity, operational connectivity, and the resulting C2 connectivity. Once the technical prearranged data items for the data link are received by the interface participants, their understanding of the interface configuration options can be enhanced if they draw out the various possible combinations for a data-link interface.

LESSON(S): Visualization of the data-link interface will help with trouble-shooting equipment malfunctions, communications outages, connectivity problems, and reconfiguration, when necessary.

One methodology for accomplishing this is:

a. Take a map and enter the general location of the interface units. On the map, and near the location of the various units, mark the type of unit and the link type or types available from that particular agency. Using the information contained in the TECHOP-DAT, connect the units using any directed configurations. If multiple options are offered, make a diagram of each option.

b. Based on the various data links available to each agency or communications available to each location, develop alternate configurations that support the primary configurations or options selected.

c. The ICU should use the primary configuration or option as a starting point for the data-link interface. By drawing out the configuration options and any alternate configurations available within an option, the interface manager and participants can visualize what is happening to the interface. When outages occur, it should be easier to rectify the outage and reestablish the interface.

TOPIC: Coordinating Configuration Changes.

DISCUSSION: Interface units were making unilateral data-link or communications configuration changes without coordinating with the ICU. The data-link interface employed was extensive. Many different participants from all of the U.S. Services, NATO and other allies employed a variety of equipment with varying data-link capabilities. The ICU is charged with the responsibility for managing this extensive network. Various units complicated their efforts by changing communications configurations and data-link configurations unilaterally.

These input changes to the interface turned a barely manageable situation into an unmanageable situation quickly. At times, coordination with the ICU was missing. The ICU could not quickly determine the current interface configuration or needed changes to maximize the performance of the interface. The ICU had incomplete information.

Changes were necessitated by communications outages or equipment outages. Several units took it upon themselves to make changes to the interface configuration or to the communication configuration without the proper coordination.

LESSON(S): Any changes to the data-link configuration must be made only at the direction of, or with the concurrence of, the ICU. Without the proper coordination, the integrity of the interface is destroyed. There should be a single agency directing changes to the data-link interface. When more than one unit attempts to control the makeup and direction of the interface, there is no unity of effort.

TOPIC*:* Interface Management.

DISCUSSION: The ICU had problems managing the data-link interface participants. The ICU had problems getting other participating units to execute the game plan for interface management. Using the parameters listed in the Technical Operational Data (TECHOPDAT), combined with the procedures in the TACOPDAT (Tactical Operational Data), the ICU maintains the unity of command. It has the responsibility to the interface participants to deal with communications outages, equipment outages or other interface problems in a timely manner to include controlling the direction the interface takes as communications, equipment availability, or unit availability changes. The ICU had reliable communications to most of the data-link participants, but was sometimes unable to manage the interface properly. Some of the interface participants had priorities different than the ICU affecting their participation. Several of the interface participants were interested in only mutual support of like airborne assets. Several of the interface participants did not have direct communications to the ICU. Each of the interface participants has the responsibility to contribute to the interface to the best of his ability. This includes informing the ICU of any anticipated outages or equipment configuration problems that are discovered.

LESSON(S): The ICU must direct the interface participants to contribute individually towards maintaining the interface, and be responsive to the need for adjusting the communications, connectivity or configuration of the interface. Conversely, the interface participants must coordinate with the ICU on any matter that affects the communications, connectivity or configurations used in the data link interface.

TOPIC: Data-link Performance Monitoring.

DISCUSSION: Periodic data-link performance monitoring by the ICU and selected interface participants was sporadic. Link monitoring and performance feedback by interface participants (coordinated through the ICU) must be conducted periodically to assess link status. This performance feedback can identify potential problems as well as assist in the trouble-shooting process. During the initial stages, link monitoring was infrequent, and the troubleshooting process was hit or miss. Some agencies failed to provide necessary equipment to trouble-shoot links, such as LSM- 11, or provided HF frequency analysis, such as chirpsounders. When fielded, automatic linking equipment (ALE) for HF radios may alleviate the shortcoming.

LESSON(S): Continual performance feedback and link monitoring are effective aids in assessing link performance and strengthening the troubleshooting process. Each capable interface participant must develop procedures to ensure that link performance is periodically monitored, assessed and documented.

TOPIC: Logbooks.

DISCUSSION: ICU Logbooks contained minimum required information which was often incomplete or vague. Information in the ICU logbooks concerning data-link performance, reconfigurations, problem description, troubleshooting, or corrective actions was often incomplete if addressed at all. This made any trend analysis or trouble-shooting of deep-rooted problems difficult, if not impossible. Accurate records must be kept by all stations participating in the interface, especially the ICU, to ensure final fixes to problems with the interface or to identify the source of problems. Accurate track counts must be taken at selected locations; performance of communications equipment monitored; configuration of the link when problems were encountered; and location of airborne platforms documented to aid in the problem-solving process. Troubleshooting and problem solving are next to impossible without adequate historical data.

LESSON(S): Recommend that ICU personnel be instructed to log information concerning data-link performance, make detailed entries concerning problems or outages and make follow-up entries outlining corrective actions for problem areas.

TOPIC: Skilled Operators.

DISCUSSION: The ICU needs to have skilled operators using established radio procedures to effectively manage the data-link interfaces. Personnel that work in the ICU should be able to readily provide information about the interface and facilitate answering policy questions. Communications procedures used by the ICU need to be clear and concise. This will provide effective, positive direction to all interface units.

Care should be taken by the ICU to ensure personnel working in or supporting the facility are knowledgeable about the current situation, the data-link interface configuration in use, current frequency assignments, and any other factors likely to affect the interface.

Personnel working in the ICU need to be able to answer questions about the interface in a timely manner. They need to either provide information themselves or be able to find answers to questions. A majority of the questions asked of the ICU concerns information needed by a unit to enter the interface. The ICU personnel need to know what current operational parameters, such as frequencies, data filters, or reference points, are in use.

Policy questions for the ICU need to be referred to the Interface Control Officer (ICO). The ICO is the only one authorized to make policy decisions affecting the interface. Personnel in the ICU that support the ICO need to be able to address the policy issues (interpret the calling party request), and not make definitive statements concerning policy.

LESSON(S): The ICU should have knowledgeable personnel that can answer questions or know where to retrieve the definitive policy-type information.

CHAPTER 5

TACTICS, TECHNIQUES, AND PROCEDURES (TTPs)

TOPIC: Information Duplication.

DISCUSSION: Several elements of information were duplicated between the Technical Operational Data (TECHOPDAT), the Tactical Operational Data (TACOPDAT), and the Air Tasking Order Confrrmation (ATOCONF) U.S. Message Text Formats (USMTFs). Within the TECHOPDAT and TACOPDAT USMTF message format, the duties set is repeated. Within the TACOPDAT and the TECHOPDAT, significant elements of the "REFUEL" set were duplicated. As used in the Operation DESERT SHIELD AOR, significant radio frequency information was duplicated among all three USMTF message types.

The duplication of information among these messages created a significant, unnecessary workload. During the development of these messages, common information elements had to be checked for correctness. Following publication, the messages, needed to be cross-checked again for potential errors in transmission.

If differences appeared, the user was then faced with the problem of determining which information was correct. Additionally, the ATOCONF contained monthly, weekly, and daily Special Instructions (SPINs). The SPINs further duplicated information in the basic message or were used to publish changes to the basic information. The MSGCHANGEREP USMTF message format was not used for this purpose. The CENTAF Director of Operations Staff should assess the current set of operational data and tasking messages to identify what information is duplicated among the various message formats. Following that assessment, which message type shall contain the basic data to be incorporated by reference to other messages should be determined.

LESSON(S): If the same sets of information are contained in multiple message formats, originators of message traffic need to determine which message will be the repository for the information and refer to that message. Do not duplicate the basic information unless the user audience is separate for each of the messages that contain that information.

TOPIC: Technical Operational Data Changes.

DISCUSSION: Revisions and changes to the TECHOPDAT were made effective prior to all interface participants receiving new parameters. During Operation DESERT SHIELD, several different TECHOPDATs or changes to the TECHOPDAT were published. One of the sets used in the TECHOPDAT format is the "EFFECTIVE" set. This set stipulates when the new parameters for the data link will be in effect. Additionally, there is a "CANX" (cancellation) set. This set identifies the TECHOPDAT to be canceled as the new TECHOP DAT becomes effective.

The implementation of the new TECHOPDAT or changes to the TECHOPDAT in effect were not properly coordinated. Some of the interface participants adopted new parameters or changed parameters before the entire interface had received the change or before all of the interface participants were ready to adopt the new parameters.

In some cases, the interface units thought that the CANX set determined to implement the new parameters. Their reasoning was the "old" parameters were canceled, use the "new" parameters now.

The ICU for a digital data interface must ensure that all of the link participants have received and understood the interface documents prior to implementation of the parameters and instructions contained in them. Complete distribution of these documents could take several days. There may be a need to transmit the TECHOPDAT, the TACOPDAT, and any changes to them via several different networks of communication. Each of the addressees must indicate to the ICU that they have received the document or changes to the document and are prepared to implement the change.

AUTODIN message traffic was exceedingly slow. Some of the interface units received message traffic from 2 to 3 days after it was transmitted. Once the TECHOPDAT or TACOPDAT are transmitted, there needs to be a 3- to 4-day wait prior to shifting to the new parameters. This delay allows sufficient time for the message traffic to be received by the user units. Operations and technical personnel will have an opportunity to review the new information and properly prepare for coordinated implementation.

LESSON(S): The TECHOPDAT, the TACOPDAT, and any interim changes to them have to be distributed to all interface participants before they are implemented. Implementation of these interface documents prior to receipt by all participants reduces the effectiveness of the digital data-link interface.

APPENDIX A

GLOSSARY OF ACRONYMS AND TERMS

A2C2	Army airspace command and control
AADC	area air defense commander
AC	Active Component
ACM	airspace control measure
ACO	airspace control order
ACUS	area common user switch
AD	air defense
AGC	automated gain control
ALE	automated linking equipment
AN/TSQ-73	U.S. Army Air Defense Command and Control System; JTAO Interface Equipment
AOR	area of responsibility
ARCENT	U. S. Army component of USCENTCOM
ASIT	Adaptable Surface Interface Terminal AN/TYC-110 for use with JTIDS Class I terminal operations by ground units
ATACS	Army Tactical Area Communications System
ATDL-1	Army Tactical Data Link-1. Used by U.S. Army to control HAWK and PATRIOT missile engagements. Used by U.S. Marine Corps TOC to control USMC HAWK
ATDS	Airborne Tactical Data System. Part of U.S. Navy tactical data system. E-2C HAWKEYE aircraft.

ATO	air tasking order. Short name for the USMTF message that tasks aircraft and control agencies to conduct air operations. See ATOCONF.
ATOCONF	air tasking order confrrmation message. Long title for the USMTF message that tasks aircraft and control agencies to conduct air operations.
AUTOCAT	Term for automatic radio relay equipment. Used by command and control agencies to extend the range of line-of-sight radios.
AUTODIN	automatic digital network
AWACS	Airborne Early Warning and Control System
C2	command and control
C3	command, control and communications
C3I	command, control, communications and intelligence
C3IC	Coalition, Coordination, Communication, and Integration Center
CAFMS	Computer-Assisted Force Management System
CANX	cancellation
CENTAF	U.S. Air Force component of USCENTCOM
CHS	common hardware software
CINC	Commander in Chief
CINCFOR	Commander in Chief, U.S. Forces Command
CONPLAN	contingency plan
CONUS	Continental United States
CRC	Control and Reporting Center. U.S. Air Force radar control facility. Part of the ground Tactical Air Command System. AN/TSQ-9 l.

CPP	control and reporting process
CRU	Crypto Reset Unit
CSCE	Communication System Control Element
CTASC	Corps Tactical Area Signal Center
CVSD	Continuously Variable Slope Delta
DAMMS-R	Department of the Army Materiel Management System-Retrofit
DATA LINK	Term for digital link between command and control facilities.
DCN	Data Link Coordination Net. Voice communications circuit between command and control agencies to coordinate the establishment.
DCO	Dial Central Office
DDN	Defense Data Network
DLRP	Data-link Reference Point
DLS-PC	Data-link Set, Portable Configuration
DMMC	Division Materiel Maintenance Center
DNVT	Digital Nonsecure Voice Terminal
DODAC	Department of Defense Activity Address Code
DPA	data processing activity
DSM	direct suppport maintenance
DSN	Defense Switching Network
DSU	Direct Support Unit

DSVT	Digital Secure Voice Terminal
EAC	echelons above corps
ECU	Environmental Control Unit
EFI	Electromagnetic Frequency Interference
FCC	Flight Coordination Center
FM	frequency modulation
FOC	Flight Operations Center
FPU	Forwarding Participating Unit. Command and control agency or equipment that is capable of forwarding between TADIL-A and TADIL-B.
FRU	Forward Reporting Unit. Command and control agency or equipment that is capable of forwarding between two TADIL-B units.
G-day	ground day - start of ground war
GMFSATCOM	Ground Mobile Forces Satellite Communications
HF	high frequency
HMMWV	High-Mobility Multipurpose Wheeled Vehicle
IADS	Integrated Air Defense System
IATACS	Improved Army Tactical Area Communications System
ICC	Interface Coordination Circuit. Voice communications circuit used by the ICU to direct the interactions of interface units.

ICO	Interface Coordination Officer. Designated person located in the Interface Control Unit (ICU) that coordinates the interactions of interface participants.
ICP	Inter-theater COMSEC Page
ICU	Interface Control Unit. Agency designation for the unit that has overall responsibility for the interaction between command and control agencies.
IJMS	Interim JTIDS Message Specification. Bit-oriented message protocol used by Joint Tactical Information Distribution System Class I terminals.
JCS	Joint Chief of Staff
JCSE	joint communications surveillance and electronics
JFACC	Joint Force Air Component Commander
JTAO	Joint Tactical Air Operations
JTADS	Joint TADIL-A Distribution System. Name for US Army equipment capable of processing TADIL-A data. Used with HAWK and PATRIOT missile systems.
JTIDS	Joint Tactical Information Distribution System
KE-3	Aircraft. Royal Saudi Air Force aircraft used for aerial refueling. Also capable of AUTOCAT operations.
LASSO	Logistics Automated System Support Office
LOS	line of sight
LPA	Log Periodic Array
MAP	Monitored Asychronous Protocol
MARCENT	U.S. Marine Corps component of USCENTCOM.

MCS	Maneuver Control System
MHz	megahertz
MNP	Microcam Network Protocol
MMC	Materiel Management Center
MPC	Message Processing Center. AN/TYC-10 U.S. Air Force equipment capable of processing and forwarding TADIL-A, TADIL-B, and NATO NADGE Link l information. Part of the USAF ground TACS.
MSE	mobile subscriber equipment
MSR	main supply route
NATO	North Atlantic Treaty Organization
NAVCENT	U.S. Navy component of USCENTCOM
NCS	Net Control Station
NTDS	Naval Tactical Data System. Surface ships capable of exchanging TADIL-A information.
OPDAT	operational data. Shortened form of either TECHOPDAT or TACOPDAT depending on whether or not it is technical operational data or tactical operational data.
OPLAN	operation plan
OPTASKLINK	U.S. Navy message that details the tactical and technical operational data for command and control operations.
PATRIOT ICC	U.S. Army missile system Information Coordination Central
PCM	Pulse Code Modulation
PLAD	plain language address

PM TACMIS	Project Manager, Tactical Management Information System.
PU	participating unit. Used with TADIL-A data-link operations. Any unit capable of transmitting or receiving TADIL-A data.
RC	Reserve Component
RF	radio frequency
RFI	radio frequency interference
RSAF	Royal Saudi Air Force
RU	reporting unit. Used with TADIL-B operations. Any unit or agency capable of exchanging tactical data using TADIL-B.
SAMS	Standard Army Maintenance System
SARSS	Standard Army Retail Supply System
SATCOM	satellite communications
SEN	small extension node
SID	Secondary Imagery Dissemination System
SPIN	special instruction. Narrative or remarks section of the air tasking order that contains any coordinating instructions for air operations.
SPIRIT	Special Purpose-Integrated Remote Intelligence Terminal
STAMMIS	Standard Army Management Information System
STU-III	secure telephone
SWA	Southwest Asia
SYSCONS	System Control Station

TACC	Tactical Air Control Center. U.S. Air Force command and control agency.
TACC-M	Tactical Air Command Center - Marine. U.S. Marine Corps command and control agency.
TACCS	Tactical Army Combat Service Support Computer System
TACOPDAT	Tactical Operational Data. USMTF message that details the tactical operational data required to effect a joint or combined interface.
TACS	Tactical Air Control System
TACSAT	tactical satellite
TADIL-A	Tactical Digital Information Link-A. A data link used between command and control agencies. This data link is half-duplex, encrypted, digital data using HF or UHF transmission media generally by units that move in air or on the water.
TADIL-B	Tactical Digital Information Link-B. A data link used between command and control agencies. This data link is full-duplex, encrypted, digital data using various point-to-point communications means.
TADIL-C	Tactical Digital Information Link-C. A U.S. Navy data link used between suitably equipped command and control agencies and Naval aircraft.
TAOC	Tactical Air Operations Center
TECHOPDAT	technical operational data. A USMTF message that details the technical prearranged data necessary link units using TADIL-A, TADIL-B, or IJMS.
TEXCOM	Test and Experimentation Command
THMT	Tactical High-Mobility Terminal
TENCAP	Tactical Exploitation of National Capabilities
TNAPS	Tactical Network Analysis and Planning System
TOE	table(s) of organization and equipment

TRI-TAC	Joint Tactical Communications
TROPO	Tropospheric Scatter Path
TSN	Track Supervision Net. A voice circuit used by data-link-capable units to coordinate track data among units.
UHF	ultra high frequency
UIC	unit identification code
USCENTCOM	United States Central Command
USMTF	U.S. Message Text Format
USN	U.S. Navy
VOLANT SOLO	U.S. Air Force EC-l30 aircraft